7.0 ENVIRONMENTAL CONSEQUENCES

7.1 Introduction

This section describes the environmental consequences that may result from this project and associated environmental mitigation. Two alternatives are addressed: the no action alternative and a rock ramp. The proposed rock ramp consists of a constant slope of 0.5%. However, the environmental consequences for each of the slope options are essentially the same, except for their respective footprints.

7.2 Adaptive Management

The rock ramp riprap will not be grouted to allow for future modifications to improve fish passage.

7.3 Ecological Resources

7.3.1 Hydrology

7.3.1.1 Introduction

This section describes the anticipated effects of the proposed alternatives on the hydrology of the Yellowstone River.

7.3.1.2 Methods

Hydrologic data from the USGS are used to evaluate hydrologic effects.

7.3.1.3 Results

7.3.1.3.1 No Action

No changes to hydrology would occur.

7.3.1.3.2 Rock Ramp Alternative

No change to hydrology is anticipated with the rock ramp alternative.

7.3.1.4 Cumulative Effects

This project has no effect on hydrology and there are no other projects in the area that would affect hydrology. Therefore, there are no anticipated cumulative effects on hydrology.

7.3.1.5 Environmental Mitigation

No mitigation measures are proposed.

7.3.1.6 Summary

There are no effects on hydrology associated with either the no action or rock ramp alternative.

7.3.2 Geomorphology

7.3.2.1 Introduction

The following section describes the anticipated effects of proposed alternatives on the geomorphology of the Yellowstone River. The characteristics assessed include bed slope, in-stream erosion/depositional patterns, and impacts to the boundaries of the active channel migration corridor.

7.3.2.2 Methods

To evaluate the effects on stream geomorphology, the effects of the proposed alternative as well as No Action have been considered based on air photo assessments of historic channel behavior, channel migration zone mapping (DTM and AGI, 2009), and existing bank protection extent (AGI and DTM, 2004).

7.3.2.3 Results

7.3.2.3.1 Channel Slope

7.3.2.3.1.1 No Action

No changes to the channel slope would be anticipated. The existing condition, which consists of a steep drop over the existing dam crest, would remain.

7.3.2.3.1.2 Rock Ramp Alternative

The Rock Ramp alternative would modify the channel slope for its entire extent. The slope would be markedly reduced at the dam face, and downstream, the channel would be steepened as the ramp feature absorbs grade in the downstream direction. The final design of the feature would define the degree to which the existing bed slope is ultimately altered; the slope of the rock ramp will likely be on the order of 0.5%. The materials used in the ramp will be designed to withstand the hydraulic changes imposed by the altered channel grade. The steep drop created by the dam will be removed and extended over a longer channel distance, improving conditions for overall connectivity and fish passage in the reach.

7.3.2.3.2 Channel Dynamics

7.3.2.3.2.1 No Action

No changes in channel dynamics would be anticipated. Bar growth, channel migration, and bank erosion would be expected to continue downstream of the dam.

7.3.2.3.2.2 Rock Ramp Alternative

The conceptual design for the rock ramp includes the construction of a berm feature between the existing island downstream of the dam and the main channel. This berm would effectively armor the riverward side of the island to prevent erosion on the margin of the ramp. Southward, the right bank of the river along the side channel would be armored as well. This bank is currently armored with concrete rubble, however that armor is discontinuous. These project elements will serve to reduce bar growth and bank erosion on the right bank downstream of the dam. Left bank armor along the ramp margin would similarly reduce erosion potential. This revetment would isolate approximately 15 acres of channel migration area mapped by DTM and AGI (2009).

The project is located in Reach C10 of the Yellowstone River Cumulative Effects Study (AGI and DTM, 2004). The reach extends approximately 4.5 miles upstream of Cartersville Dam, and 2.5 miles downstream. Within this 6.9-mile long reach, a physical features inventory performed in 2002 indicated that a total of 22% of the bankline was armored at that time. The rock ramp alternative with a slope of 0.5% will include armoring of approximately 1,200 feet on the left bank and 700 feet on the right bank. With an estimated additional 1,900 feet of bank armor, the total length of armored bankline in the reach will increase from 22% to 25% (Table 7-1).

Table 7-1
Bank Protection Inventory, Reach C10

Feature	Existing (ft)	Existing (% of bank length)	Proposed (ft)	Proposed (%)
Dike/Levee	4859	7%	4859	7%
Bank Armor	15959	22%	17,859	25%

Because Cartersville Dam is located at Forsyth, the reach shows relatively high extents of existing bank protection. From Billings to Miles City, 29 mapped reaches depict an average bank armor extent of 15% (AGI and DTM, 2004). In Reach C10 at Forsyth, 22% of bank length currently protected by armor. The relatively high armoring extents in this reach reflect the urbanized condition in the reach, and the associated attempts to prevent lateral channel migration and bank erosion. As such, although the project

will increase the extent of bank armor in the reach by approximately three percent, the fact that the reach is in a relatively developed area renders it prone to armoring regardless of project implementation.

The rock ramp alternative will reduce the scour potential of the river bed downstream of the dam structure. When the armored berm is overtopped, scour on its downstream side is likely, and this scour may result in the erosion of the edge of the existing island. Final design efforts will consider this scour potential and design the downstream-sloping face of the berm accordingly.

7.3.2.4 Cumulative Effects

From Billings to Miles City, mapped erosion control features occupy approximately 322,000 feet of bankline, or approximately 15% of banks (AGI and DTM, 2004). An addition of 1,900 feet, or less, of bank armor at Cartersville will increase the total bank armor length by 0.1%. This increase in cumulative bank protection is offset by the net benefit of the project to the Yellowstone River fishery.

7.3.2.5 Environmental Mitigation

For the rock ramp alternative, no mitigation measures are proposed due to the net benefit of the project to the Yellowstone River fishery. Bank armor should be designed to minimize the impacts to fishing access.

7.3.2.6 Summary

The No Action Alternative will not affect channel slope, bank migration patterns, bar development, or channel migration zone area.

The long term effects of the Rock Ramp Alternative include a modification of the channel slope at Cartersville Diversion to a more natural gradient such as that surveyed at Matthews Rapid downstream. The inclusion of bank armor on the margins of the structure will increase in a 3% increase in total armored bank length in the reach, and a 0.1% increase in bank armor length in the river segment that extends from Billings to Miles City. This armoring will result in the isolation of approximately 15 acres of area previously mapped as within the 100-year channel migration zone. The armored berm that extends from dam downstream to the northern margin of the island area will increase scour potential on its downstream side. This scour potential will be considered in final design.

7.3.3 Federally-Listed Species and State Species of Special Concern

7.3.3.1 Introduction

The following section describes the anticipated effects of proposed alternatives on federally-listed species and state species of special concern in the vicinity of Cartersville Dam. The species considered include:

golden eagle, great blue heron, greater sage-grouse, bald eagle, spiny softshell, greater short-horned lizard, blue sucker, sturgeon chub, paddlefish, and sauger.

7.3.3.2 Methods

To evaluate the effects on federally-listed species and state species of special concern, the effects of the proposed rock ramp alternative as well as no action have been considered based on potential impacts to migration, feeding, nesting, and reproduction.

7.3.3.3 Results

7.3.3.3.1 Golden Eagle

7.3.3.3.1.1 No Action

The no action alternative will have little or no effect on golden eagle populations.

7.3.3.3.1.2 Rock Ramp Alternative

Golden eagles tend to inhabit upland grassland habitats. Consequently, the rock ramp alternative is not anticipated to affect migration patterns or feeding or nesting habitat for golden eagles.

7.3.3.3.2 Great Blue Heron

7.3.3.3.2.1 No Action

The no action alternative will have little or no effect on great blue heron populations.

7.3.3.3.2.2 Rock Ramp Alternative

The rock ramp alternative is not anticipated to affect nesting habitat or migration patterns of great blue herons. However, the rock ramp alternative may have some impact on great blue heron feeding. These birds prefer to feed by wading in slow-moving water up to 18 inches deep or from the shoreline or occasionally when perched on rocks in deeper water. The rock ramp alternative will transform approximately 20 acres of the Yellowstone River from slower moving, deep water habitat to fast-moving, shallower rapid habitat. This may reduce the amount of feeding habitat available to great blue herons, especially along the shoreline where they are more likely to feed. Most of the river away from the shoreline is probably not used by herons and therefore, will not result in any loss of feeding habitat.

7.3.3.3.3 Greater Sage-Grouse

7.3.3.3.3.1 No Action

The no action alternative will have little or no effect on greater sage grouse populations.

7.3.3.3.3.2 Rock Ramp Alternative

Greater sage grouse tend to inhabit upland grassland habitats. Consequently, the rock ramp alternative is not anticipated to affect migration patterns or feeding or nesting habitat for greater sage grouse.

7.3.3.3.4 Bald Eagle

7.3.3.3.4.1 No Action

The no action alternative is expected to have little or no impact on bald eagle populations.

7.3.3.3.4.2 Rock Ramp Alternative

The rock ramp alternative is not anticipated to affect nesting habitat or migration patterns of bald eagles. However, the Cartersville Dam is likely to concentrate fish at the toe of the dam, thereby increasing food availability for bald eagles. At the same time, the dam also limits the extent of some fish species that bald eagles utilize for food. Consequently, the rock ramp alternative is expected reduce food availability locally, but may benefit bald eagle feeding regionally by improving fish populations bald eagles rely upon as food.

7.3.3.3.5 Spiny Softshell

7.3.3.3.5.1 No Action

Dams are thought to create migration impediments or barriers for spiny softshell turtles. Although the dam at Cartersville is relatively low and spiny softshells may be able to walk around the dam abutments, the existing structure is likely to impede the upstream movement of this species. Consequently, the no action alternative is anticipated to continue having a negative impact on spiny softshell populations.

7.3.3.3.5.2 Rock Ramp Alternative

The rock ramp alternative will transform approximately 22 acres of the Yellowstone River from slower moving, deep water habitat to fast-moving, shallower water rapid habitat. This section of river is currently too swift to be considered optimal habitat for spiny softshells, so the overall impact of constructing the rock ramp is expected to be slight. The rock ramp is also expected to have positive impacts by removing a potential migration barrier to spiny softshells.

7.3.3.3.6 Greater Short-horned Lizard

7.3.3.3.6.1 No Action

The no action alternative will have little or no effect on greater short-horned lizard populations.

7.3.3.3.6.2 Rock Ramp Alternative

Greater short-horned lizards tend to inhabit uplands with sandy or gravelly soils. Impacts of the rock ramp alternative will be limited primarily to the river channel and, therefore, are not expected of affect greater short-horned lizard populations.

7.3.3.3.7 Blue Sucker

7.3.3.3.7.1 No Action

Blue suckers make long upstream migrations to spawn. Helfrich et al. (1999) found that the distribution of several native riverine species were restricted by diversion dams on the Yellowstone River during low water years. They reported the upstream distribution above Cartersville Dam for several fish species, including blue sucker, is restricted by this structure. Consequently, the no action alternative will continue to have a negative impact on blue sucker populations.

7.3.3.3.7.2 Rock Ramp Alternative

The rock ramp alternative will benefit blue sucker populations by providing passage and connectivity for this fish species to habitat upstream in the Yellowstone River and its tributaries.

7.3.3.3.8 Sturgeon Chub

7.3.3.3.8.1 No Action

It is unclear whether Cartersville Dam creates a migration barrier to sturgeon chubs. Helfrich et al. (1999) did not include sturgeon chub in their list of several native riverine species that were restricted by diversion dams on the Yellowstone River. However, the small size of this fish species would suggest that Cartersville Dam may present a passage impediment. Consequently, we suggest that the no action alternative will negatively impact sturgeon chub populations.

7.3.3.3.8.2 Rock Ramp Alternative

Assuming sturgeon chub are capable of passing natural rapids in the Yellowstone River, the rock ramp alternative will benefit sturgeon chub populations by improving passage and connectivity for this fish species to habitat upstream in the Yellowstone River and its tributaries.

7.3.3.3.9 Paddlefish

7.3.3.3.9.1 No Action

Paddlefish make long upstream migrations to spawn. Helfrich et al. (1999) found that the distribution of several native riverine species were restricted by diversion dams on the Yellowstone River during low water years. They reported the upstream distribution above Cartersville Dam for several fish species, including paddlefish, is restricted by this structure. Consequently, the no action alternative will continue to have a negative impact on paddlefish populations.

7.3.3.3.9.2 Rock Ramp Alternative

The rock ramp alternative will benefit paddlefish populations by providing passage and connectivity for this fish species to habitat upstream in the Yellowstone River and its tributaries.

7.3.3.3.10 Sauger

Spawning by sauger is often accompanied by migration upstream and/or into tributary streams in the spring, with long migrations occurring in the Yellowstone River. Helfrich et al. (1999) found that the distribution of several native riverine species were restricted by diversion dams (including Cartersville) on the Yellowstone River during low water years. They reported the upstream distribution above Cartersville Dam for several fish species, including sauger (especially juvenile sauger), is restricted by this structure. Consequently, the no action alternative will continue to have a negative impact on paddlefish populations.

7.3.3.3.10.1 Rock Ramp Alternative

The rock ramp alternative will benefit sauger populations by providing passage and connectivity for this fish species to habitat upstream in the Yellowstone River and its tributaries.

7.3.3.4 Cumulative Effects

The construction of a rock ramp fish passage structure at Cartersville Dam will benefit federally-listed species and state species of special concern in the same way natural riffles benefit these species. When added to the effects of modifying Intake Dam on the Yellowstone River, and the T&Y and SH dams on the Tongue River, the cumulative effect of these fish passage improvements will have significant positive benefits for fish (e.g. paddlefish, blue sucker and fish-dependent species (e.g. bald eagle) in the Yellowstone River. Negative cumulative effects for other species are expected to be negligible.

7.3.3.5 Environmental Mitigation

For the rock ramp alternative, no mitigation measures are proposed due to the net benefit of the project to the Yellowstone River fishery.

7.3.3.6 Summary

The no action alternative will have no affect on most species, but will have negative impacts on fish (e.g. sturgeon) and fish-dependent species (e.g. piscivors).

In contrast, the rock ramp alternative will transform 22 acres of the Yellowstone River from slower moving, deep water habitat to fast-moving, shallower water rapid habitat. In addition, this alternative will result in armoring approximately 2,100 feet of river bank with rock riprap. These channel alterations are expected to have a net benefit to federally-listed species and state species of special concern.

7.3.4 Lands and Vegetation

7.3.4.1 Introduction

The following section describes potential impacts to lands and vegetation by the "No Action" alternative and the Rock Ramp alternative for Cartersville Dam.

7.3.4.2 Methods

Impacts of each alternative (No Action and Rock Ramp) were overlaid on existing lands and vegetation maps to estimate potential impacts to these resources.

7.3.4.3 Results

7.3.4.3.1 Vegetation

7.3.4.3.1.1 No Action

The no action alternative will have little or no impact on existing vegetation at the Cartersville Dam site.

7.3.4.3.1.2 Rock Ramp Alternative

Construction of the rock ramp alternative will be limited primarily to the area between the tops of the river banks. In the north channel, the rock ramp will extend from the dam downstream for a distance of 1400 feet, or less, with the north river bank receiving rock bank protection and the north island bank receiving a rock berm. The south channel will be armored on the south bank for approximately 700 feet. Most of the impacts to vegetation will be associated with placement of 2100 feet of bank protection. The river bank on both sides of the channel is relatively devoid of vegetation except for sparse forbs and grasses below the high water mark. In addition, the south bank is already protected with some bank armor, which limits vegetation. As such, the rock ramp alternative is expected to have relatively minor impacts to vegetation communities.

7.3.4.3.2 Wetlands

7.3.4.3.2.1 No Action

The no action alternative will have little or no impact on existing wetlands at the Cartersville Dam site.

7.3.4.3.2.2 Rock Ramp Alternative

Construction of the rock ramp alternative will result in filling approximately 22 acres of waters of the US. In addition, the rock ramp will result in filling jurisdictional wetlands along the banks where rock protection is installed. In all, approximately 2100 feet of bank will receive rock protection. Assuming an average width of approximately 30 feet, the total impact would be 1.45 acres. A wetland delineation will need to be completed during final design to determine exact quantities impacts to wetlands and other waters of the US.

7.3.4.4 Cumulative Effects

Cumulative effects of the rock ramp alternative will be limited primarily to wetlands. According to Montana's Department of Environmental Quality, Montana has lost approximately one-third of its naturally occurring wetlands since settlement. The proposed rock ramp alternative will add to the cumulative loss of wetlands in Montana and, therefore, will require mitigation to offset this loss.

7.3.4.5 Environmental Mitigation

Placement of fill within the river channel to construct the rock ramp is expected to be self mitigating as it will result in transforming approximately 22 acres of slower moving, deep water riverine habitat to fast-moving, shallower water rapid habitat. Placement of fill to protect the river banks will result in filling an estimated 1.45 acres of jurisdictional wetlands, which will require mitigation. Assuming these wetlands can be mitigated at a ratio of 2:1, the project would require the construction of approximately 3.9 acres of mitigation wetlands. Final mitigation requirements for placement of fill and wetlands will need to be worked out with the Army Corps of Engineers, Montana Department of Environmental Quality, and other responsible agencies following a wetland delineation and final design of the rock ramp alternative.

7.3.4.6 Summary

The no action alternative will have no impacts to existing lands or vegetation. In contrast, the proposed rock ramp will impact waters of the US and jurisdictional wetlands and, therefore will require mitigative actions.

7.3.5 Aquatic Assemblages

7.3.5.1 Introduction

This section describes the anticipated effects of proposed alternatives on the aquatic communities in the project area. The communities assessed include fish, macroinvertebrate, and mussels.

7.3.5.2 Methods

We reviewed the literature pertaining to aquatic communities in the area, and studies that assessed fish movement at diversion dams in the Yellowstone River.

7.3.5.3 Results

7.3.5.3.1 Fish Assemblages

7.3.5.3.1.1 No Action

Currently, Cartersville Dam appears to block upstream movement of shovelnose sturgeon (Jaeger et al. 2009) as well as juvenile sauger (Jaeger et al. 2005). Although Helfrich et al. (1999) reported that Cartersville Dam did create any disjunct fish populations; it is likely that upstream passage is impeded for some proportion of the 40-50 fish species present in the project area. For example, total numbers of shorthead redhorse, goldeye, *Hybognathus sp*. (likely western silvery minnow), emerald shiner, and river carpsucker were higher below Cartersville Dam than above it. The total number of all fish species fish captured was also higher below Cartersville.

7.3.5.3.1.2 Rock Ramp Alternative

The rock ramp design for Cartersville is based on the experiments of White and Mefford (1993) and the characterization of flow conditions at Matthews rapid, which is known to allow upstream passage of shovelnose sturgeon (Jaeger et al. 2006; sturgeon movement figures in Appendix A). The resultant design is very likely to allow upstream passage of shovelnose sturgeon as well as the endangered pallid sturgeon, because shovelnose sturgeon and pallid sturgeon have similar morphology and appear to have similar swimming abilities (Bramblett and White 2001; Adams et al. 2003). Swimming performance data are lacking for most of the diverse fish assemblage in this reach of the Yellowstone River. However, the Cartersville rock ramp will very likely allow passage of most of the other fish because there are no fish species know to occur downstream of Matthews Rapid and not upstream of this rapid (Montana Fish, Wildlife and Parks, Montana Fisheries Information System (MFISH)). Therefore, Matthews Rapid is likely not a barrier to fish species in the Yellowstone River, and presumably a rock ramp design based on hydraulic conditions at Matthews Rapid will allow passage of all fish species. Improving upstream passage would increase connectivity among fish populations in the Yellowstone River. This is a benefit

to the fish populations because well-connected populations are less vulnerable to extirpation and have more genetic diversity. Increasing connectivity may allow access to previously unavailable spawning, rearing and foraging areas and may therefore increase fish populations in the Yellowstone River. Improved passage of game fish species such as sauger, channel catfish, and paddlefish may allow for improved recreational fishing opportunities above Cartersville.

Reconnecting anthropogenically-disconnected river reaches entails a risk of allowing unwanted or invasive species access to newly-reconnected habitats. For example, there are about 20 introduced fish species in the Yellowstone River (White and Bramblett 1993). Of these, 16 species already occur above and below Cartersville Dam; therefore proving upstream passage will not affect their distribution (MFISH). This includes piscivorous (fish-eating) species such as smallmouth bass, northern pike, and walleye. Four species (rock bass, white bass, rainbow smelt, and goldfish) occur within the Yellowstone River basin only below the Cartersville Dam. Rock bass and smallmouth bass likely gained access to the Yellowstone River after stocking in Tongue River Reservoir. Perhaps smallmouth bass, a strong swimmer, were able to pass upstream of Cartersville Dam whereas rock bass were not. Rock bass eat invertebrates and also prey upon small fishes (Scott and Crossman 1973), such as the abundant minnows that occur in the Yellowstone River.

White bass and rainbow smelt occur in the Yellowstone River below Intake diversion dam (MFISH). These two species gained access to the lower Yellowstone River following stocking in Lake Sakakawea in North Dakota. White bass are visual piscivores that prefer clear water and tolerate cool water temperatures (Scott and Crossman 1973). Apparently they are not well-established in the lower Yellowstone River; perhaps due to the higher turbidities common there. Rainbow smelt are an anadromous species where there is access to the ocean, but they have become established in freshwaters such as the Great Lakes. Rainbow smelt are primarily invertivorous, tolerate cool water temperatures, and can move long distances in rivers (Scott and Crossman 1973). It may be limited by high turbidities in the lower Yellowstone River, but may thrive in upper reaches where there is lower turbidity. If fish passage is provided at Intake, these two species may ascend the river to Cartersville, and above Cartersville if fish passage is provided there. If white bass were to gain access to the middle and upper river, they may become established and prey upon native minnows such as emerald shiners, and compete with native fishes such as sauger. Rainbow smelt would prey upon invertebrates and small fishes, as well as provide forage for piscivorous fishes. Goldfish have not become well established in the Yellowstone River basin (Brown 1973; Holton and Johnson 2003); therefore they are unlikely to expand their distribution if passage is provided at Intake and Cartersville.

Construction activities will disturb approximately 22 acres of river bottom. This will minimally impact fish assemblages. Adult and juvenile fishes are mobile and most will likely be able to avoid construction activities that could cause direct mortality. Larval fishes have low mobility and may be killed by construction activities. However, fishes typically produce abundant larvae that suffer high levels of natural mortality and are resilient to moderate and short-term increases in mortality rates. The localized spatial and short-term temporal impacts of this project will likely not significantly increase mortality rates of fishes in lower Yellowstone River.

The river at the project site has two channels; a primary channel to the north of the existing island and a smaller side channel south of the island. The conceptual design for the rock ramp includes the construction of a berm feature beginning on the south river bank, and continuing to and extending along the north bank of the existing island. The design also includes a "fishing hole" in the south channel, adjacent to the city park. The rock ramp will allow fish passage in the main (north) channel, but not in the side channel south of the island. Fish entering the south (side) channel will not be able to pass upstream directly, but would have to turn around, enter the north (main) channel and then pass upstream over the rock ramp. This design may temporarily impede upstream movement of some fish. The slower, shallower, and potentially warmer water in the south channel may attract fish species such as minnows, and potentially some game fish such as channel catfish or sauger. It is likely that a local concentration of fish will occupy the "fishing hole" at the upstream end of the south channel where they could be exposed to considerable angling pressure. However, because the majority (80%) of the flow will be in the north channel, and this channel will have more attraction flow and will be deeper and wider, it is likely that a large majority of the fish will use the north channel and will be able to pass upstream. Shovelnose sturgeon do not orient strongly to current velocities below 2.0-2.5 ft/s, and attraction flows of 2 to 4 ft/s are recommended for fishway designs to pass shovelnose sturgeon (White and Mefford 1999). Therefore, shovelnose sturgeon will likely avoid the south channel and use the north channel to pass the rock ramp. Although passage of a proportion of fish will be impeded because of the design of the south channel as a whole the rock ramp will likely allow a large majority of fish to pass upstream. Therefore, the lack of passage in the south channel will be a minor and localized impact, and allowing fish passage on the north channel will be a major benefit to the fish assemblage.

7.3.5.3.2 Macroinvertebrates

7.3.5.3.2.1 No Action

No changes in macroinvertebrate comminutes is anticipated.

7.3.5.3.2.2 Rock Ramp Alternative

Aquatic insect dispersal is probably not currently affected by Cartersville Dam. Aquatic insects drift downstream with the current; Cartersville Dam does not prevent drift. Following emergence as adults, aquatic insects are able to fly upstream to lay eggs, thereby preventing depletion of upstream habitats. Construction of a rock ramp fishway at Cartersville will not affect aquatic insect dispersal. Disturbance of the river bottom associated with rock ramp construction will kill large numbers of aquatic invertebrates. Newell (1973) reported invertebrate densities of 100 to over 10,000 individuals/ft^2. Construction activities will also create turbidity and sediment deposition locally. Sediment fills interstices in gravel and cobble and can smother invertebrates living there. However, these impacts will be localized and will not affect macroinvertebrate communities at larger scales for several reasons. Macroinvertebrates readily drift from upstream to colonize disturbed areas, macroinvertebrates have short life cycles and can repopulate rapidly, and macroinvertebrates in the project are adapted to relatively high levels of turbidity and sedimentation.

7.3.5.3.3 Mussels

7.3.5.3.3.1 No Action

No changes in mussel communities are anticipated.

7.3.5.3.3.2 Rock Ramp Alternative

Freshwater mussels disperse upstream in streams and river when the host fish to which their parasitic larvae (glochidia) are attached move upstream. The glochidia later drop off and begin an independent life on the stream bottom. The only mussel currently found in the project area is the fatmucket (*Lampsilis siliquoidea*). However, the general distribution of this species will not change with construction of a rock ramp fishway at Cartersville, because fatmuckets are already found upstream in the Yellowstone River basin at least as far as the mouth of the Bighorn River (Aquatic Invertebrates of Montana webpage, Daniel L. Gustafson, Montana State University). Three introduced freshwater mussel species (giant floater, *Pyganodon grandis*; white heelsplitter, *Lasmigona complanata*; black sandshell, *Ligumia recta*) occur in the Missouri River basin, including below Fort Peck Reservoir. These species may eventually colonize the Yellowstone River if fish passage improves and their host fish move out of the Missouri River and up the Yellowstone River. Disturbance of the river bottom associated with rock ramp construction may kill unknown numbers of freshwater mussels. However, this impact will be localized and will likely affect a very small portion of the mussel population of the lower Yellowstone River.

7.3.5.4 Cumulative Effects

The cumulative effect of fish passage projects at Intake Dam and Cartersville is to open up a large section of the Yellowstone River for fish passage.

7.3.5.4.1 Environmental Mitigation

For the rock ramp alternative, no mitigation measures are proposed due to the net benefit of the project to the Yellowstone River fishery and minimal impacts to the macroinvertebrate and mussel communities.

7.3.5.5 Summary

The No Action Alternative will benefit fish assemblages as a whole, albeit with a low risk of allowing white bass and rainbow smelt to colonize the middle Yellowstone River. There will minimal impact to macroinvertebrate and mussel communities.

7.3.6 Recreation

7.3.6.1 Introduction

This section describes the anticipated effects of proposed alternatives on recreation in the project area.

7.3.6.2 Methods

We consulted Montana Fish, Wildlife and Parks MFISH webpage and existing literature for information on fishing in the project area.

7.3.6.3 Results

7.3.6.3.1 Recreational Fishing

7.3.6.3.1.1 No Action

The area adjacent to and below Cartersville Dam would remain a popular fishing location.

7.3.6.3.1.2 Rock Ramp Alternative

The river at the project site has two channels; a primary channel to the north of the existing island and a smaller side channel south of the island. The conceptual design for the rock ramp includes the construction of a berm feature beginning on the south river bank, and continuing to and extending along the north bank of the existing island. The design also includes a “fishing hole” in the south channel, adjacent to the city park. The rock ramp will allow fish passage in the main (north) channel, but not in the side channel south of the island. Fish entering the south (side) channel will not be able to pass upstream directly, but would have to turn around, enter the north (main) channel and then pass upstream

over the rock ramp. This design may temporarily impede upstream movement of some fish, and the "fishing hole" may allow fish to stay below the berm. The slower, shallower, and potentially warmer water in the south channel may attract fish species such as minnows, and potentially some game fish such as channel catfish or sauger. It is likely that a local concentration of fish will occupy the "fishing hole" at the upstream end of the south channel where they could provide very good recreational fishing. However, it is difficult to predict precisely how fishing may change as a result of providing fish passage at Cartersville. It is likely that fish will stage below the rock ramp and continue to provide good fishing at the project site. Fish passage is an important component in providing healthy fish populations and will benefit the Yellowstone River fishery as a whole.

People using the existing boat ramp on the south bank immediately downstream of the dam would proceed around the upstream end of the island to deep water in the north channel. With the rock ramp alternative, this will not be possible and the south channel frequently does not have enough water for boat passage.

7.3.6.4 Cumulative Effects

It is anticipated that this project and the proposed Intake Dam fish passage project downstream near Glendive, Montana will benefit the Yellowstone River fishery as a whole.

7.3.6.5 Environmental Mitigation

With the rock ramp alternative a new boat ramp will be pursued on property currently privately owned downstream of the existing state park on the south bank of the river downstream of the dam (Figures 7-1 and 7-2).

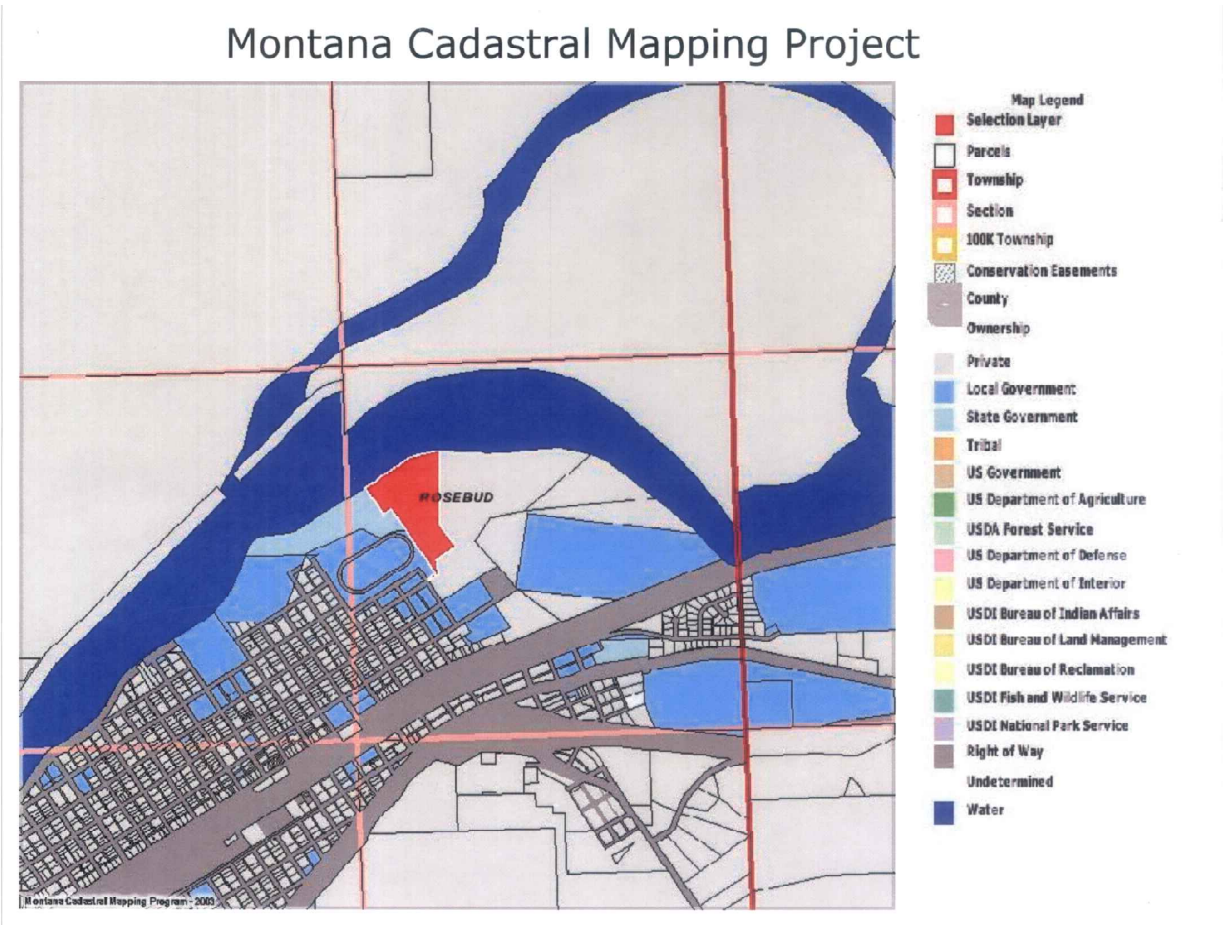

Figure 7-1 Ownership Map for New Boat Ramp

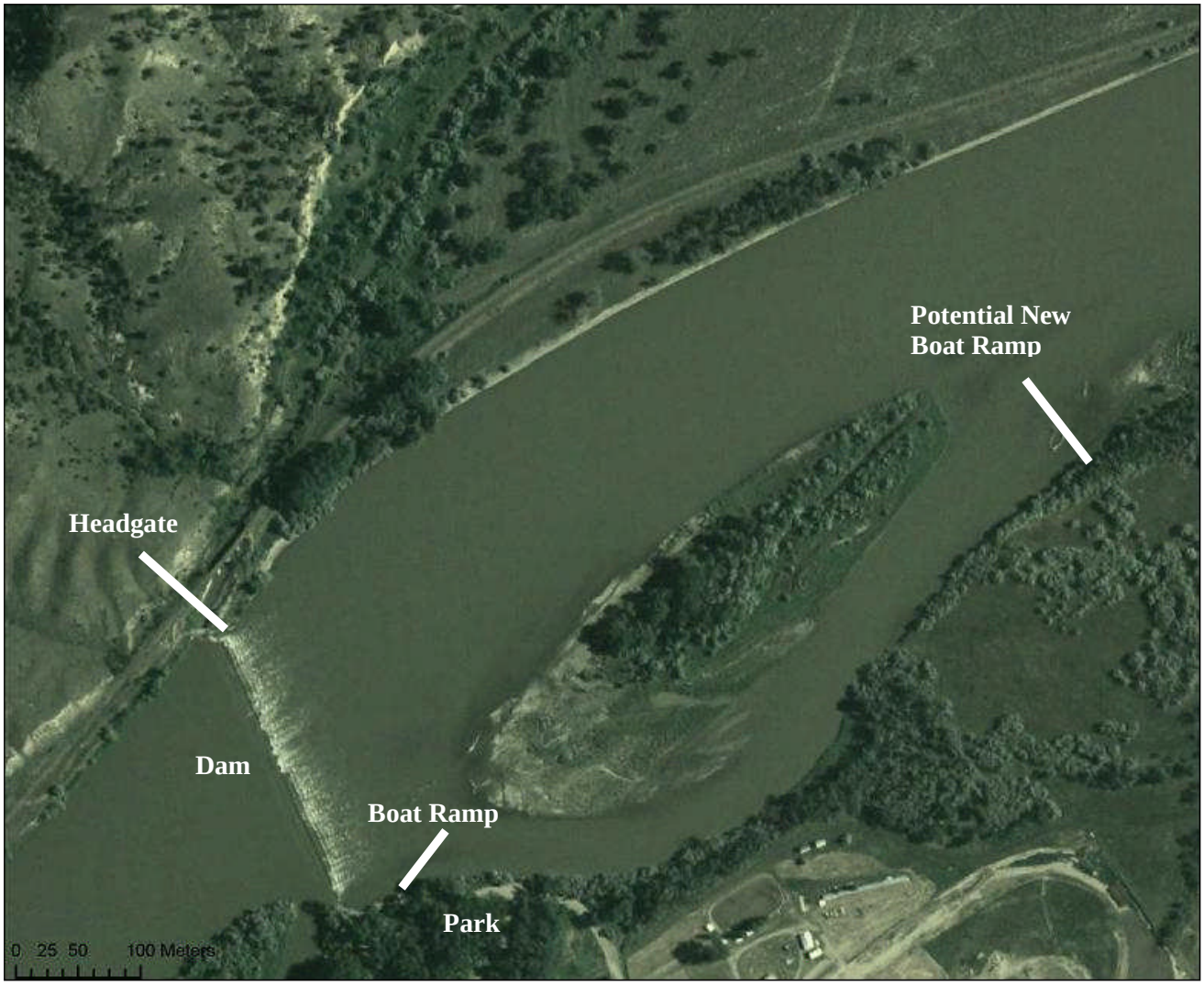

Figure 7-2 Location of New Boat Ramp

7.3.6.6 Summary

The rock ramp alternative will benefit the Yellowstone River fishery. A new boat ramp will allow boaters to continue to access the river near the park, downstream of the dam.

7.4 Cultural Resources

7.4.1 Introduction

This section addresses the anticipated effects of proposed alternatives on cultural resources.

7.4.2 Methods

The Montana Historical Society, State Historic Preservation Office was consulted regarding potential effects.

7.4.3 Results

7.4.3.1 No Action

The no action alternative could potentially result in failure of the dam and the loss of this cultural resource.

7.4.3.2 Rock Ramp Alternative

The rock ramp alternative would buttress the downstream side of the dam, but leave the existing dam intact. The benefit of preventing a failure of the dam outweighs any negative consequences.

7.4.4 Cumulative Effects

The proposed project to construct a rock ramp at Intake Dam near Glendive is similar in nature to that proposed at Cartersville. If their construction is similar, there may be cumulative cultural resource impacts.

7.4.5 Environmental Mitigation

During the design/permitting phase of the project there must be coordination with SHPO to determine what mitigation, if any, is required.

7.4.6 Summary

The rock ramp alternative may have an impact on cultural resources, and a cultural resource inventory should be performed during design/permitting to identify the need for any mitigation.

7.5 Aesthetic Resources

7.5.1 Introduction

This following section addresses anticipated effects of proposed alternatives on an aesthetic resources.

7.5.2 Methods

Information regarding potential effects was obtained by input from the community.

7.5.3 Results

7.5.3.1 No Action

The no action alternative could potentially result in failure of the dam and the loss of its aesthetic value to the community.

7.5.3.2 Rock Ramp Alternative

The rock ramp alternative would buttress the downstream side of the dam, minimizing the risk of failure. In addition, the rock ramp would provide aesthetic values similar to natural rapids, which many people find appealing. The south channel of the Yellowstone River will stay in its current configuration, as desired by the community. The community has expressed approval of the concept of a rock ramp in the north channel.

7.5.4 Cumulative Effects

There should be no cumulative effects to people in the community.

7.5.5 Environmental Mitigation

No environmental mitigation is anticipated.

7.5.6 Summary

The no action alternative could result in failure of the dam and its aesthetic value. The rock ramp alternative should reduce the probability of failure and perpetuate the aesthetic resources of the park and river.

7.6 Surface Water Quality

7.6.1 Introduction

The following section describes the anticipated effects of proposed alternatives on the surface water quality of the Yellowstone River. Anticipated impacts are associated with channel bed disturbances during project construction, and as such are temporary.

7.6.2 Methods

The summary provided is based on publications produced by the Montana Department of Agriculture (http://agr.mt.gov), Montana Department of Environmental Quality (http://deq.mt.gov), and the United States Geological Survey (Zelt, et al, 1998; Miller et al, 2004).

7.6.3 Results

As a Class B-3 water body, the Yellowstone River at the project site is subjected to the following standards: Suitable for drinking, culinary and food processing purposes, after conventional treatment; bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply (http://deq.mt.gov).

From the Big Horn River to Cartersville Dam, the river has been listed as partially supporting of the warm water fishery, and the probable cause of this impairment is listed as a fish passage barrier. Between Cartersville Dam and the Powder River, the Yellowstone has been listed as partially supporting of aquatic life and the warm water fishery. The probable causes for this impairment include riparian alterations, nitrate/nitrite, pH, sediment, copper, lead, and zinc. To date, Total Maximum Daily Loads (TMDLs) have not been developed for listed waterbody.

Potential impacts to the surface water quality associated with the project include increases in turbidity or other chemical parameters due to disturbance of the channel bed during construction.

7.6.3.1 Suspended Sediment

7.6.3.1.1 No Action

No impact to suspended sediment concentrations are anticipated under a No Action Alternative.

7.6.3.1.1 Rock Ramp Alternative

The excavation and associated disturbance of the river bed as part of construction efforts will result in a temporary increase in downstream turbidity. A sediment management plan designed to monitor, control, and minimize that turbidity will be required by project contractors. Upstream of the existing dam, sediment deposition will continue in a similar fashion as the No Action alternative.

7.6.3.2 Dissolved Solids, Pesticides, and Nutrients

7.6.3.2.1 No Action

No impact to dissolved solids, pesticides, or nutrient concentrations area anticipated under a No Action Alternative.

7.6.3.2.1 Rock Ramp Alternative

Where the channel bed is to be disturbed or excavated, no sediment samples are available to compare their chemistry to that of the existing water column. As such, there is no means of assessing the relationship between any disturbed substrate and existing dissolved solid, pesticide, or nutrient

concentrations. Any potential contaminants identified during construction will be addressed to minimize impacts to the surface water chemistry.

7.6.4 Cumulative Effects

The implementation of appropriate environmental mitigation measures will result in minimal and temporary impacts to surface water quality. The project will address the existing water quality impairment listing for the river upstream of the dam by removing the existing warm water fish passage barrier.

7.6.5 Environmental Mitigation

Environmental mitigation during and following project construction will include appropriate best management practices to minimize increases in turbidity and water quality degradation, to minimize the potential for aquatic life impacts downstream. These approaches will include materials handling procedures to prevent the spillage of materials into the active channel, revegetation of disturbed areas, application of erosion control measures and monitoring of those measures to ensure that both wind and water erosion is minimized, and safe handling of spills on the construction site such as fuel, lubricants, or chemicals in accordance with state laws and regulations.

7.6.6 Summary

The effects of the project on surface water quality can be mitigated using appropriate best management practices.

7.7 Air Quality

7.7.1 Introduction

The following section describes the anticipated effects of the proposed alternatives on air quality.

7.7.2 Methods

There is no ambient air quality data available in the vicinity of Forsyth, Montana.

7.7.3 Results

7.7.3.1 No Action

No impact to air quality is anticipated under the No Action Alternative.

7.7.3.2 Rock Ramp Alternative

Any short-term effects from such things as dust and exhaust fumes from construction equipment should be minor.

7.7.4 Cumulative Effects

This project will not combine with other projects in the area to impact air quality.

7.7.5 Environmental Mitigation

Environmental mitigation during construction will include appropriate best management practices. Construction activities that could raise dust should be coordinated with the Rosebud County Fair.

7.7.6 Summary

The proposed alternatives will have only short term effects on air quality.